

TASK PLAN
for
Phase B
of the
Gravity Recovery and Climate Experiment
(GRACE) Mission

to the
NASA Goddard Space Flight Center

April 21, 1997

Prepared by:

Approved by:

E. S. Davis
Project Manager

C. A. Yamarone, Manager
Earth Science Flight Projects

Approved by:

C. Elachi, Director for
Space and Earth Science Program

JET PROPULSION LABORATORY
California Institute of Technology
Pasadena, California 91109

TABLE OF CONTENTS

	<u>PAGE</u>
I. TECHNICAL SECTION	
A. INTRODUCTION	
B. BACKGROUND	
C. PROGRAM MANAGEMENT APPROACH	
D. PROJECT MANAGEMENT APPROACH.	
E. SYSTEMS ENGINEERING.	
F. PERFORMANCE ASSURANCE.	
G. SAFETY.	
H. LAUNCH VEHICLE INTERFACE REQUIREMENTS. . .	
II. BUSINESS AND COST SECTION	
A. SCOPE OF WORK	
B. DELIVERY SCHEDULE	
C. PERIOD OF PERFORMANCE	
D. COST ESTIMATE	

I. TECHNICAL SECTION

A. INTRODUCTION

The GRACE Mission will produce a new model of the Earth's gravity field every 12 to 24 days for a period of five years. This sample interval allows for separation of the temporal and static gravity field components providing both a high-accuracy static field and its time variations. The GRACE Mission will acquire the data for the gravity fields by flying two polar-orbiting satellites in a loosely controlled tandem formation. Variations in the Earth's gravity field will cause the distance between the two satellites to vary. This variation will be measured with 1 micron precision by a microwave link between the two satellites. Analysis of this data will result in numerous advances in earth science relating to oceanography, atmospheric measurements and monitoring of polar ice.

This Task Plan defines the work to be performed by JPL during Phase B to: 1) define and establish detailed requirements for flight and ground control segments and mission operations of the Gravity Recovery and Climate Experiment (GRACE) Mission, 2) to fabricate a prototype of the satellite-to-satellite tracking instrument, and 3) to initiate long-lead-time procurements.

B. BACKGROUND

In July 1996, the Office of Mission to Planet Earth (OMTPE) at NASA Headquarters released the first Announcement of Opportunity for the Earth System Science Pathfinder (ESSP) Program. The ESSP Program is intended to accomplish high quality, focused Earth System Science measurements utilizing innovative, streamlined management and implementation approaches designed to yield high-value science. The GRACE Mission proposal was selected after a rigorous, two-phased selection process.

The GRACE Mission is a team effort being led by Dr. Byron Tapley of the University of Texas Center for Space Research (UTCSR). Dr. Tapley's Co-Principal Investigator is Dr. Christoph Reigber of the GeoForschungsZentrum-Potsdam (GFZ). The GRACE Mission Team consists of UTCSR, the Jet Propulsion Laboratory (JPL), Space Systems Loral (SS/L), NASA's Langley Research Center (LaRC), Dornier Satellitensysteme (DSS) and under an International Memorandum of Understanding between NASA and DARA, the GeoForschungsZentrum-Potsdam (GFZ), and the Deutsche Forschungsanstalt für Luft und Raumfahrt (DLR).

C. PROGRAM MANAGEMENT APPROACH

NASA HQ Code IY will provide support in the development of a Memorandum of Understanding (MOU) with international partners on the GRACE Mission. For all other aspects of the GRACE Mission, NASA HQ has delegated program management

responsibility for the GRACE Mission to the ESSP Project Office at the Goddard Space Flight Center (GSFC). The GSFC ESSP Project Office will provide mission funding, contract administration and programmatic oversight for the GRACE Mission. To implement the GRACE Mission, GSFC will provide funds directly to three members of the GRACE Team - UTCSR, JPL, and LaRC. Furthermore, GSFC may provide mission unique support, only as may be requested by the PI in writing and agreed upon by the ESSP Project office. This support may be in the form of support personnel, equipment, parts/supplies, or facilities from GSFC or other Government sources. In the event that such support is requested, a portion of the PI's Mission funds would be retained by the ESSP Project Resources Office, to be disbursed as directed by the PI.

ESSP missions are to be implemented under a "Principal-Investigator Mode" (PI Mode) in order to reduce mission development times, costs and schedules and achieve NASA's goals within the current budget constraints. In the PI-Mode, the PI takes full responsibility for all aspects of the mission, including instrument and spacecraft definition, development, integration, and test; ground system operations, science operations, mission operations, and data acquisition and distribution with the intention of allowing the PI the maximum flexibility to conduct the investigation.

The PI will establish and lead a team consortia, optimizing the specialized talents of the various participant organizations. The PI will have the responsibility and accountability to accomplish the mission within the program's cost and schedule constraints. The PI's team will use their own processes, procedures and methods to the fullest extent practical, and also develop new ways of doing business where cost, schedule and technical improvements can be achieved. Periodic progress reporting will combine cost, schedule and technical status using the team's own internal management reviews to meet the Government's reporting requirements. The PI will submit an annual cost and obligation plan and submit monthly reports of actual costs and obligations. If either the PI or GSFC determines that the mission cannot be completed within the agreed upon constraints, a termination review will be held. In the ESSP Program, the PI is accountable to NASA for Mission success and is given full responsibility for all aspects of the Mission.

The University of Texas Center for Space Research (UTCSR) and the GRACE Mission Team, under the leadership of Dr. Byron Tapley, shall take full responsibility for all aspects of the GRACE Mission from definition through mission operations and data distribution. The GRACE Mission shall meet the requirements contained within the Gravity Recovery and Climate Experiment Mission Definition and Requirements Agreement (MDRA) and be consistent with the design, development and operations plan as presented in the GRACE Proposal dated December 10, 1996.

JPL will be funded directly from the ESSP Project Office, but will be directly responsible to Dr. Tapley for their performance on the GRACE Mission. More specifically, the ESSP Project office at GSFC will be providing technical direction authority on this

contract with the concurrence of Dr. Byron Tapley of the University of Texas Center for Space Research. As defined in an International MOU being negotiated between NASA and

DARA, German Mission Team members are under the direction of Dr. Reigber, with Dr. Tapley maintaining overall responsibility for their performance as well.

Similarly, LaRC will be funded directly from the ESSP Project Office, but will be directly responsible to JPL for their performance on the GRACE Mission. More specifically, the ESSP Project office at GSFC will delegate technical direction authority over the LaRC effort to JPL.

The Phase-B Study for the GRACE Mission will culminate in a Mission Design and Cost Review (MDCR) for the GSFC ESSP Project Office which will serve as a Confirmation Review for proceeding to Phases C/D/E. This review is expected to consist of a Non-Advocate Review (NAR)-style programmatic review. Contingent upon successful completion of the MDCR and confirmation by NASA, it is the intention of GSFC to contract with JPL and the GRACE Mission team to proceed with Phases C/D/E. In order to allow time for formal confirmation without delaying the mission, the GRACE Mission Team shall with GSFC approval, commence the initial design and development of the mission flight and ground control segment under this contract immediately following the MDCR.

D. PROJECT MANAGEMENT APPROACH

The PI shall have overall responsibility for the work specified by this contract. The PI shall approve the designation of a single individual as Project Manager at JPL and shall delegate to this individual the requisite responsibility and authority to manage and administer the effort to implement the GRACE Mission. This individual shall be the focal point of contact for GSFC. This individual shall ensure that all of the objectives associated with the implementation effort are accomplished within schedule and cost constraints, and provide timely reporting of overall progress.

JPL, with the concurrence of UTCSR, shall establish, implement and maintain a management system which integrates management disciplines (scientific and technical), functions, and systems into an overall activity to achieve cost-effective planning, organizing, controlling, and reporting of the contract objectives. The day-to-day management and administration of the specified work are the prime objectives of this task. As part of this effort, JPL shall provide traceability of cost, schedule and technical progress data for work being performed by Mission Team members and subcontractors in support of this contract.

All funding for long-lead part purchases made prior to official confirmation by the MDCR Review Panel, must be approved by the ESSP Project Office.

GRACE Mission Project Documents, and Memoranda of Understanding will be made available to the ESSP Project Office for review and comment in a timely manner.

JPL, under the guidance of UTCSR, shall be the U.S. interface with DARA, GFZ and DLR for matters of project management. JPL shall collaborate with the PI and Co-PI in assuring that German-provided services and materials meet the technical and schedule constraints of the GRACE Mission.

1. Schedules

JPL, in consultation with UTCSR, shall establish, implement and maintain a scheduling management function which develops, monitors and maintains the master schedule and derivative detailed schedules for the GRACE Mission development activities. These schedules shall establish the interrelationships and time-phasing of activities and events essential for the timely and effective implementation of the program, and shall identify critical paths and schedule slack. The master level-1 schedule, dated May 28, 1997, (attachment #1) shall constitute the "baseline" schedule and shall come under configuration control consistent with the program configuration management procedures.

2. Monthly Progress Reports

JPL shall submit to UTCSR Monthly Progress Reports utilizing narrative text, graphs and/or schedules, which shall include but not necessarily be limited to:

- a) Summary Status - Summarize the current contract and schedule status. Identify any anticipated changes in scheduled milestones. Provide current status of all critical path items and report schedule slack. Provide current status of all mission critical technical resources (mass, power, etc.), including margins or reserves. Provide current status of mission cost reserves, including liens.
- b) Major Accomplishments - Summarize achieved accomplishments versus planned accomplishments for the previous month and delineate planned accomplishments for the next month.
- c) Current Problems - Present a "Top Ten" list of problems. State progress toward solving problems previously identified and discuss new problems that have been identified during the past month, including schedule for resolution. State whether action by, or assistance from, either Mission Team Management or GSFC is required. Identify potential work around positions if a problem will have a significant impact on the on-time completion of the contract or on critical scheduled milestones.
- d) Problem Avoidance - Recommend action by either Mission Team Management or GSFC which would assist in preventing major potential problems from developing.

- e) Risk Management Status Report - Update the list of the high risk items, discussing any risk mitigation actions which were implemented and a status of upcoming risk decision points.
- f) Facility Status Report - Discuss the status of facilities.

The Monthly Progress Report shall be submitted as three (3) hard copies and electronically to the ESSP Project Office at GSFC, with an accompanying teleconference or presentation. The location of any monthly presentations shall be determined by mutual consent of the UTCSR, JPL and the ESSP Project Office.

JPL, together with UTCSR shall conduct quarterly status reviews with the ESSP Project Office. These reviews shall include up to date information on technical, cost, schedule and other programmatic issues. These reviews shall be conducted in person at either the ESSP Project Office or at a GRACE Mission Team member's facility.

3. Monthly and Quarterly Contractor Financial Management Reports (533M/533Q)

JPL shall submit to UTCSR monthly and quarterly (533M and 533Q or equivalent) financial management, or equivalent, reports as described in NPG 9501.2B "NASA Contractor Financial Management Reporting" (April 1996). GRACE financial management reports shall be prepared according to the WBS and cost element structure contained in the GRACE proposal dated December 10, 1996, or as agreed upon by JPL, the UTCSR and the ESSP Project Office. Financial management reporting shall be provided at the total cost/manpower level for WBS Level III and by cost element for WBS Level II. 533M and 533Q reporting shall be required for first-tier subcontracts that meet the reporting requirements set forth in NASA FAR Supplement Section 18-42.7201 (b) (1). JPL shall also provide contract funding profiles, as required, and explain variances between projected and actual costs that are reported on 533M and 533Q reports.

4. Reviews and Meetings

JPL, in collaboration with UTCSR, shall provide the necessary resources to prepare technical and programmatic data packages for distribution and presentation at the Mission Design and Cost Review, to be conducted by a GSFC-appointed review panel. Advance copies of the presentation package shall be submitted to the ESSP Project Office for review at least 10 working days prior to the formal presentation.

JPL, in collaboration with UTCSR, shall also conduct a Project Requirements Review and shall establish a review board responsible for conducting the reviews and evaluating the status of the program. The team shall be comprised of individuals who have extensive experience with spaceflight programs and are independent of the GRACE Mission.

The ESSP Project Office shall be invited to attend all meetings and reviews conducted by the GRACE Mission Team.

5. Science Management

JPL shall be responsible for collaborating with UTCSR in the definition of the GRACE instruments, defining operation of the PODAAC and the post-launch acquisition, processing, archiving and distribution of the GRACE science data. The Baseline and Minimum Science Mission requirements shall be documented in the GRACE Science and Mission Requirements Document.

E. SYSTEMS ENGINEERING

JPL, in cooperation with UTCSR, shall establish a systems engineering capability which shall be responsible for integrating the technical efforts of the entire GRACE definition team to ensure that the performance objectives of the Mission are met with minimum risk. This function shall: 1) define and flow down the mission requirements for the GRACE Mission and incorporate these requirements into the GRACE Science and Mission Requirements Document; 2) perform trade studies and status assessments to support the management decision making process; 3) support the risk management process by identifying and characterizing risks and developing appropriate risk mitigation approaches; 4) define all functional and physical interfaces, both internal and external to the Instrument and Satellites, and verify that they reflect the requirements for all GRACE systems elements (hardware, software, facilities, personnel and data); 5) define all functional and physical interfaces for the ground system, including PODAAC; 6) define all functional and physical interfaces between the Instrumentation subsystem and the satellites and the Satellites and the ground support equipment (GSE); 7) define all functional and physical interfaces between the Satellites and the launch vehicle; and 8) be responsible for all necessary systems level engineering activities associated with specialty disciplines which include, but are not limited to, reliability, contamination control, electromagnetic interference, space charging, and radiation effects.

F. PERFORMANCE ASSURANCE

JPL, in consultation with UTCSR, shall establish, implement and maintain a performance assurance program for both hardware and software development which is consistent with ISO 9000 requirements. This program shall be documented in a Mission Assurance Plan for the GRACE Mission, and shall apply to all work performed by JPL, its subcontractors and suppliers, and its team members. Effective management, control and implementation of the quality function is the prime objective of this task.

G. SAFETY

JPL , in consultation with UTCSR, shall establish, implement and maintain a system safety program that accomplishes the following:

1. Identifies and controls hazards to personnel, facilities, support equipment, and the flight system during all stages of mission development. The program shall address hazards in the flight hardware, associated software, ground support equipment, and support facilities.
2. Meets the system safety requirements stated in the applicable launch site safety regulation.
3. Meets the baseline industrial safety requirements of the institution, as well as any special contractually imposed mission unique obligations.

The safety program shall be documented in a Safety Plan for the GRACE Mission, and shall apply to all work performed by JPL, its subcontractors and suppliers, and Mission Team members.

H LAUNCH VEHICLE INTERFACE REQUIREMENTS

JPL, in consultation with UTCSR, shall assure that all launch interface requirements for the GRACE Mission are met.

II. BUSINESS AND COST SECTION

A. SCOPE OF WORK

In Phase B, the Jet Propulsion Laboratory (JPL) shall provide the facilities, materials, services and personnel necessary to define and establish detailed requirements, plans and specifications as well as initiate long-lead-time procurements for the GRACE Mission. This shall include, but not be limited to:

1. Develop, in collaboration with UTCSR and the GRACE Mission Team, a brief Project Implementation Plan for the Phase-B effort. The plan should include a description of Phase-B activities, schedules, roles and responsibilities of Mission Team members and a list of Phase-B deliverables. The plan is due at the beginning of Phase B.
2. Support negotiations for all agreements between domestic, as well as international partners, for example agreements including International Memorandums of Understanding (IMOU), Project Memorandums of Understanding (PMOUs), and Launch Services Agreements;
3. Negotiate and establish contracts with subcontractors to JPL for the Phase-B effort;
4. Develop the GRACE Mission Level-1 Requirements including instrument, spacecraft, ground system and mission operations;
5. Develop, in collaboration with UTCSR, the GRACE Baseline and Minimum Science Requirements;
6. Coordinate, in consultation with UTCSR, GFZ, and the DLR, the development of an overall GRACE Mission Operations Concept and the Ground System Development Plan, including the ground element of the telemetry and command system, the mission operations center, the GPS ground receiver network, the science data processing center, and the interfaces with EOS DIS;
7. Develop a preliminary design of the spacecraft, instrument and GSE;
8. Develop a mission operations ground system specification;
9. Develop a specification for the satellites their instrumentation and the supporting GPS ground tracking network ;
10. Develop specifications for elements of the satellite instrumentation subsystem;

11. Develop preliminary Interface Control Documents between the elements of the instrumentation and the satellites, and between the flight segment and the ground control segment;

12. Establish and document the interface requirements between the GRACE flight segment and the launch vehicle services;
13. Develop, in collaboration with UTCSR, a GRACE Mission Software Development Plan;
14. Perform feasibility studies on the CG Trim Mechanism;
15. Perform feasibility studies on the Attitude Control System;
16. Develop and test a prototype of the satellite-to-satellite tracking instrument;
17. Perform, in collaboration with UTCSR, mission design trades required during the definition phase;
18. Develop, in consultation with UTCSR and other Mission Team members, a Risk Management system to be documented in the Phase C/D/E Project Implementation Plan, which includes a Risk Mitigation and Descoping Plan, meeting the following minimum requirements:
 - Identification of the high risk items with an associated risk mitigation plan for each, updated as necessary
 - A prioritized descoping of the Mission from the Baseline Science Mission to the Minimum Science Mission, including latest practical decision dates, in the event of a forecast of cost, schedule, or technical margin erosion. This should include a list of critical milestones, which if not met will require the immediate attention of the GRACE Management Team.
19. Develop, in consultation with UTCSR, a set of recommended performance metrics for program evaluation by NASA and the Mission Team, including cost, schedule, and others as appropriate;
20. Order long lead parts or take other measures, as necessary, to reduce schedule risk;
21. Develop the Mission Assurance Plan and necessary supporting procedures;
22. Develop the Safety Plan and necessary supporting procedures;
23. Develop a preliminary Contamination Control Plan commensurate with the mission requirements;

24. Submit monthly progress and financial reports to UTC SR, as defined in Section I, para. D.2 and para. D.3;

25. Develop a configuration management plan for managing and controlling the design, fabrication, test programs, and all other configuration management activities associated with the mission;
26. Prepare and submit, in collaboration with UTCSR, an updated Phase C/D/E Project Implementation Plan and Phase C/D/E Cost Plan, due at the MDCR, and which shall include the following as a minimum:
 - A revised cost plan with supporting data, in the same format and level of detail as required by the ESSP Announcement of Opportunity AO-96-MTPE-01, in real year dollars, which separately reflects costs for Phases C/D and E and includes a fully executed SF1411;
 - A Mission Development Plan for the design, development and operation of the mission flight and ground hardware and software, including launch, mission operations, and data processing and distribution;
 - A set of mission schedules with schedule slack and critical path(s) explicitly shown;
 - Management and decision-making roles and responsibilities of all GRACE Project organizations;
 - Technical roles and responsibilities of all GRACE Mission organizations;
 - Finalized versions of all Team Agreements, International Memorandums of Understanding and Project Memorandums of Understanding for the GRACE Mission
27. Collaborate in the definition of the GRACE Mission with UTCSR and NASA/GSFC by participating in programmatic and technical meetings as appropriate.
28. Develop, in collaboration with UTCSR and the ESSP Project Office, the presentation material for and present the material, as necessary, at the MDCR;
29. Develop, in collaboration with UTCSR, a Phase-B final report, which may consist of the MDCR presentation package and response to MDCR action items.

B. DELIVERABLES

1. A Project Implementation Plan for the Phase-B effort per Section II, para. A.1. - due at the beginning of Phase B (Nominally April 1, 1998).
2. Monthly financial reports, per Section II, para. A.24, to begin with acceptance of the task plan;

3. Monthly progress reports, per Section II, para. A.24, to begin with the month of January 1998;
4. An updated Phase C/D/E Project Implementation Plan and Phase C/D/E Cost Plan, per Section II, para. A.18 and para. A26 - due at the MDCR (Nominally November, 1998);
5. Presentation material for the MDCR per Section II, para. A.28- due at least 10 days prior to the MDCR (Nominally November, 1998);
6. Present and discuss the material delivered in Section II, para. B.5 at the MDCR (Nominally November, 1998);
7. A Phase-B final report per Section II, para. A.29 - due at the end of Phase B (Nominally December 31, 1998).

C. PERIOD OF PERFORMANCE

The period of performance is from April 21 1997, through December 31, 1998.

D. COST ESTIMATE OF PHASE B

The total budget for the effort is . The breakdown of the budget is presented in the attached tables.